Considerations for Implementing

Digital Signatures

at the

U. S. Department of Energy

April 16, 1998

Assistant Secretary for Human Resources and Administration
Deputy Assistant Secretary for Information Management

Foreword

Digital signature technology is still quite new, and many issues have been identified for more in-depth examination. This initial issuance of ***Considerations for Implementing Digital Signatures at the Department of Energy*** provides an overview of the technology as initial guidance for implementation at DOE. The document provides questions to be answered and issues to be addressed in future updates. As such, it provides an introduction to describing the steps necessary to: develop, implement, and maintain a reliable means of secure electronic messaging (when text is also encrypted) over open, unsecured computer networks; minimize or eliminate the incidence of forged digital signatures and possible fraud in electronic transactions; and establish standards and procedures for verification and reliability of electronic transactions. Because the digital signature environment is dynamic, it is important to develop guidelines that will promote interoperability.

This document is intended for both technical and nontechnical audiences. It should be helpful to anyone contemplating the implementation of digital signature for any application. Program managers, legal staff, records managers, software support staff, and security specialists should all benefit from understanding these considerations. It should be of particular interest to staff involved in setting up Public Key Infrastructures.

The following aspects of implementing digital signatures are discussed.

- **Public Key Infrastructure -** Third parties may perform the service of verifying and certifying the association between a digital signature and a particular person or entity. Such a third party may also serve as a repository for these certificates. This third party is known as a certification authority.

- **Digital Signature Applications** - Digital signatures can be used for e-mail, electronic funds transfer, electronic data interchange, software distribution, data storage (to provide verification of integrity of data at a future time), and other applications that require data integrity assurance and data origin authentication.

- **Digital Signature Standards -** The standards presented in this document are already part of the DOE profile of adopted IT standards. These standards represent guidance for achieving interoperability Departmentwide, Governmentwide, and with the private sector.

- **Records Management -** Usually records management concerns are not particularly considered when implementing new technology. However, with digital signature implementations, it becomes important to include records managers in the planning stages.

- **Legal Considerations -** The formal requirements for legal transactions, including the need for signatures, vary in different legal systems and with the passage of time. Implementing requirements for creating and verifying a digital signature accomplishes the essential elements needed for legal purposes.

Table of Contents

Chapter 1. Digital Signature Overview

What Is a Digital Signature?

With the ever-increasing use of electronic technology, it is necessary to establish a framework for authenticating computer-based information. Electronic messages are rapidly replacing paper in today's environment. These messages are migrating beyond private, limited-function communications to open networks, such as the Internet, with unlimited uses. Because open networks lack rigorous access and usage controls, they are basically insecure. Consequently, electronic messages are particularly susceptible to altering, tampering, or forging. Digital signatures are a technological answer to these problems.

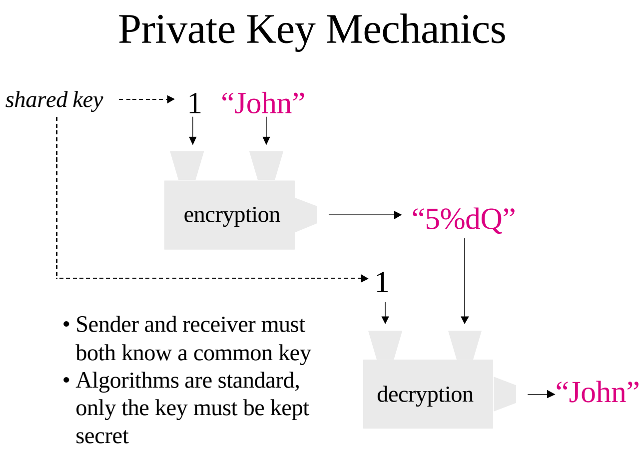
Digital signatures are key to the viability of electronic commerce, both from a commercial and a legal standpoint. Business information exchanged and activities performed must have the same level of authentication as that of paper-based exchanges and activities that are legally enforceable. Digital signatures are one way to accomplish this.

A digital signature is not a pen-and-ink signature nor is it a handwritten signature scanned into a computer and attached to an electronic message. A digital signature is the result of a two-step process that is performed on the message by encryption software that has been loaded onto the sender's computer. Although a digital signature is not handwritten, the process of creating a digital signature and verifying it provides electronically the same effects that a handwritten signature on paper provides. A digital signature enables users to determine who sent a document, identify what document was sent, and determine whether the document was altered in route. It reasonably ensures the recipient that the message came from an identifiable sender and contains a specific, unaltered message. It may be used where sufficient confidence in the source, content, and integrity of a transaction is necessary. A digital signature ensures that a message is authentic, its integrity has not been compromised, and the sender cannot disavow or repudiate the message after sending it.

For a digital signature to work effectively, three obstacles must be overcome. First, a recipient must be able to reliably associate with the sender the private and public key pair used to encrypt and decrypt the message digest. Unlike a pen-and-ink signature, a public-private key pair has no intrinsic association with a particular person. The keys are just large numbers. Second, a recipient needs a trustworthy source from which to obtain the public key needed to verify the message. Third, a digital signature must have the same legal effect as a handwritten signature on a paper document.

Description of Digital Signature Cryptography

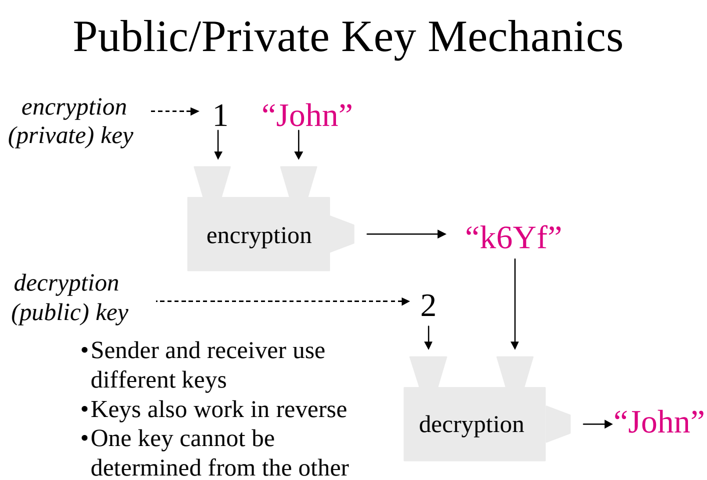
Digital signatures are created and verified by cryptography, which transforms messages into unintelligible forms and back again. Digital signatures employ public key cryptography, which uses an algorithm with two different, but mathematically related keys: one key is for creating a digital signature or transforming the data into an unintelligible form; and the other key is for verifying a digital signature or returning the message to its original form.



The complementary keys for digital signatures are termed the private key (known only to the signer and used to create the digital signature) and the public key (more widely known and used by a relaying party to verify the digital signature). A public key can be available to anyone needing to verify the signer's digital signature. The public key can reside in an online repository or directory where it is easily accessible. Although the two keys are mathematically related, it is not computationally feasible to derive the private key from knowledge of the public key. Although many people may know a signer's public key and use it to verify the signer's signature, they cannot discover the signer's private key and use it to forge a digital signature.

Another process called a hash function is used in creating and verifying a digital signature. A hash function is an algorithm that creates a digital representation or fingerprint in the form of a hash value of a standard length that is usually smaller than the message, but unique. Any change to the message produces a different hash result when the same hash function is used. Hash functions enable the software for creating digital signatures to operate on smaller and predictable amounts of data, while still providing robust evidentiary correlation to the original message content. Therefore, hash functions efficiently provide assurance that there has been no modification of the message since it was digitally signed.

Typically a digital signature (a digitally signed hash result of the message) is attached to its message and stored or transmitted with its message. However, it may also be sent or stored as a separate data element, so long as it maintains a reliable association with its message. Since a digital signature is unique to its message, it is useless if disassociated from its message.



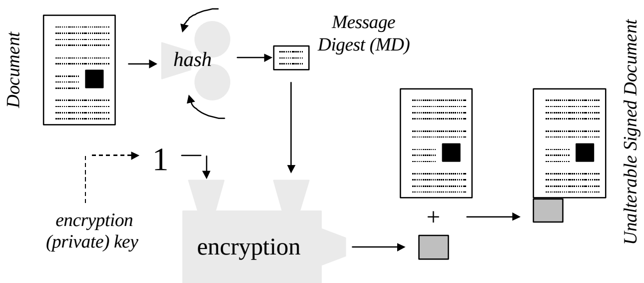
The Digital Signature Process

The digital signature process assumes two users have agreed upon a hash function and a signature algorithm for the signature verification process. An originator who needs to send a signed message performs the following.

- Generates a digest for the message
- Computes a digital signature as a function of the digest and the originator's private key
- Transmits the message and signature to the recipient.

How Does Public/Private Key Provide a Signature ?

- A message digest is appended to the document



Upon receiving the message, the recipient performs the following procedure.

- Generates a digest for the message received
- Uses the digest, the originator's public key, and the signature received as input to a signature verification process.

If the signature is verified, the recipient is assured that the message was not modified and that the originator sent the message. If any portion of the original message was changed, the digest generated using the received message causes the signature verification process to fail.

Benefits of Digital Signatures

Digital signatures, if properly implemented and used, offer solutions for the following.

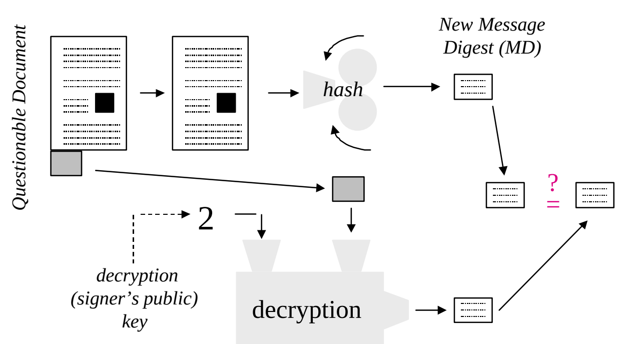
- **Impostors**: Minimizes the risk of dealing with impostors or people who try to deny responsibility by claiming to have been impersonated;

- **Message Integrity**: Minimizes the risk of undetected message tampering and forgery and the claim that a message was altered after it was sent;

- **Formal Legal Requirements**: Strengthens the view that legal requirements, such as writing, signature, and original document, are satisfied since digital signatures are more valid than paper forms;

How Does Public/Private Key Provide Authentication?

- The message digest can be later validated



- **Open Systems**: Retains a high degree of information security, even for information sent over open, insecure, but widely used channels.

Business Case

When making a business case for using digital signature, an important consideration is whether a digital signature is really needed as opposed to a simple electronic approval. In many cases, signatures are affixed to paper documents because it is an expedient and easily available way to do business, not because a legally binding, unalterable signature is needed.

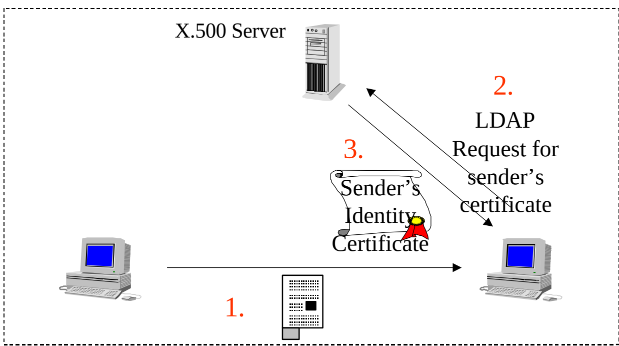
When reengineering a work process, in addition to making it paperless, it is important to analyze whether a signature is really a necessary part of the process. At least for pilot implementation of digital signature, where there will be a high overhead and steep learning curve, it will be important to choose applications that truly require authentication/non-repudiation.

Chapter 2. Public Key Infrastructure

In order to verify a digital signature, the verifier must have access to the signer's public key and have assurance that it corresponds to the signer's private key. In transactions involving only two parties, each party can simply communicate the public key of the key pair each party will use. As electronic commerce moves to the Internet where significant transactions occur, the problem of authentication/nonrepudiation becomes one of efficiency and reliability.   A Public Key Infrastructure (PKI) provides the means to bind public keys to their owners and helps in distributing reliable public keys in large heterogeneous networks.   PKI allows persons without prior knowledge of each other to engage in verifiable transactions.

So, where do I get somebody's public key?

•Ans: You ask our X.500 server for a copy of their certificate



ANL Trust Domain

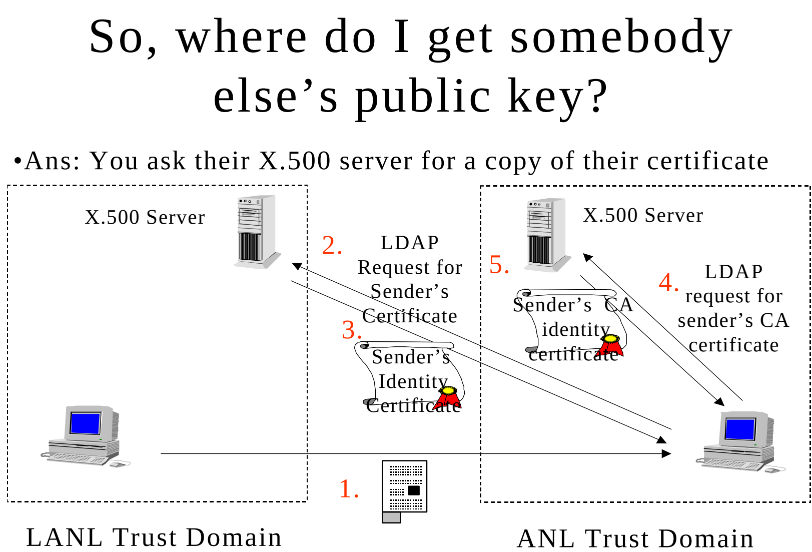
PKI uses one or more trusted third parties to associate an identified signer with a specific public key. That trusted third party is referred to as a certificate authority (CA).   CAs issue a digital certificate that identifies the CA issuing it, identifies the subscriber, contains the subscriber's public key, and is digitally signed with the CA's private key. To obtain a digital certificate, the subscriber who wants to digitally sign a message or document presents a copy of his public key along with sufficient proof of identity to the CA. Once satisfied as to the identity of the subscriber, the CA issues the subscriber a digital certificate. To make a public key and its identification with a specific signer available for use in verification, the certificate is published in a repository or directory. Certificates can be automatically retrieved by having the verification program directly access the repository.

When the subscriber wants to use the digital signature, he transmits a copy of his digital certificate to the recipient of his digitally signed message. Upon receipt of the signed message, the recipient's computer confirms with the CA identified in the digital certificate that the sender is who he purports to be and that his certificate has not expired or been revoked.   All of this activity is transparent to the recipient.

Certificate authorities certify public keys, create and distribute certificates, and generate and distribute certification revocation lists, which are posted on a designated repository or directory. A certification revocation list contains the serial number of certificates that have been reported by their owners as having been compromised

A certificate infrastructure provides a uniform way to obtain certificates in spite of the possible differences in certificate management policies used by different segments of the infrastructure. In addition, mechanisms are provided to enable each user to be aware of the policies governing any certificate encountered.

With a certificate authority infrastructure in place, a relying party can be reasonably assured that the document is what it purports to be and that the signer is a particular person. There will be institutional overhead associated with establishing and utilizing certification authorities and repositories, and there will be costs to signers and relying parties. On the other hand, problems associated with imposters, message integrity, and formal legal requirements can be resolved.



It is necessary to consider the integrity and security of the PKI components. The confidence that can be placed in the binding between a public key and its owner depends on the confidence that can be placed on the system that issued the certificate that binds them. Provisions in the X.509 standard (addressed in the standards chapter) enable identification of policies that indicate the strength of mechanisms used and the accepted standards of certificate handling. By examining the policy associated with a sender's certificate, the recipient of a signed or encrypted message can determine whether the binding between the sender and the sender's key is acceptable and thus accept or reject the message.

The Department of Energy has developed Chapter 9 of the Telecommunications Security Manual, DOE M 200.1-1, which "defines the roles, requirements, and responsibilities for establishing and maintaining the documentation necessary to ensure that all certificates are managed in a manner that maintains the overall trust required to support a viable PKI."

Chapter 9 applies to all certification authorities or certification authorizations on behalf of DOE and requires the development of certificate policy documents and certification statements that are approved by the DOE Policy Management Authority. The certification authorities that apply perform the following functions.

- Participate in cross-certifying with DOE PKI operated by DOE Policy Management Authority

- Issue certificates used to process or protect Unclassified Controlled Nuclear Information (UCNI), Official Use Only (OUO), and other federal, sensitive unclassified information that requires encryption

- Issue certificates for the following purposes:

  -- To establish financial obligations for, or on behalf of, the federal government;

  -- To establish or verify identity of recipient of information when authority to receive such information is already established; and

  -- To establish or verify identify of recipient to access classified computing resources when authority is already established.

The chapter sets forth requirements for DOE elements that have implemented or plan to implement public key systems. The requirements shall be used to establish minimum DOE operational policies and procedures to assess CA operations. Chapter 9 also addresses establishing an organizational structure and defines responsibilities of the CAs, registration authorities, etc.

Chapter 3. Digital Signature Applications

Uses of digital signature are endless.   Some of the potential uses at DOE are:

- Electronic commerce
- Fully integrated electronic support of work processes such as travel
- Official personnel documentation - W-4 forms, time cards, personnel actions
- Secure unclassified communications where end-to-end authentication and non-disclosure are required - faxes, e-mail, video conferencing, remote log-in
- Technical drawings and other images - protection of access to research data (drawings), time-stamping procedures for proof of patent, disclosure protection of drawings in transit and storage.   Drawings associated with weapons data would be included in this category
- Virus detection before a program is executed, since even a minute change is detected
- Authentication and access control to web pages and web forms
- Electronic laboratory notebooks as legal records for patent considerations. This involves the issues of date and time stamping of the contents of the electronic notebook, and verification that the contents of the electronic notebook are a complete and unaltered record. This must all be done in a fashion that is verifiable and acceptable to the courts before widespread utilization of the electronic notebook.
- Contracting - Ensuring that contract agreements that have occurred in an electronic (non face-to-face environment) are enforceable. Implementation of contract bidding and formation on a large scale without the individual bid issuers having to establish a personal trust relationship with the organizations/contractors in question.
- Information transfer or publication - Issue "official" web pages through the use of well-known public-keys, vouched for by Internet-trusted third-parties, such as Verisign, GTE CyberTrust, USPS   The previously unintroduced parties are the web-site and the end-users such as reporters, investors, etc.
- Sharing R&D and technology transfer information with universities and scientists world-wide
- Authorizing remotely-operated experiments
- Acting as a software bus for exchanging information between applications

The availability of digital signature applications to satisfy these requirements is discussed in the following sections.

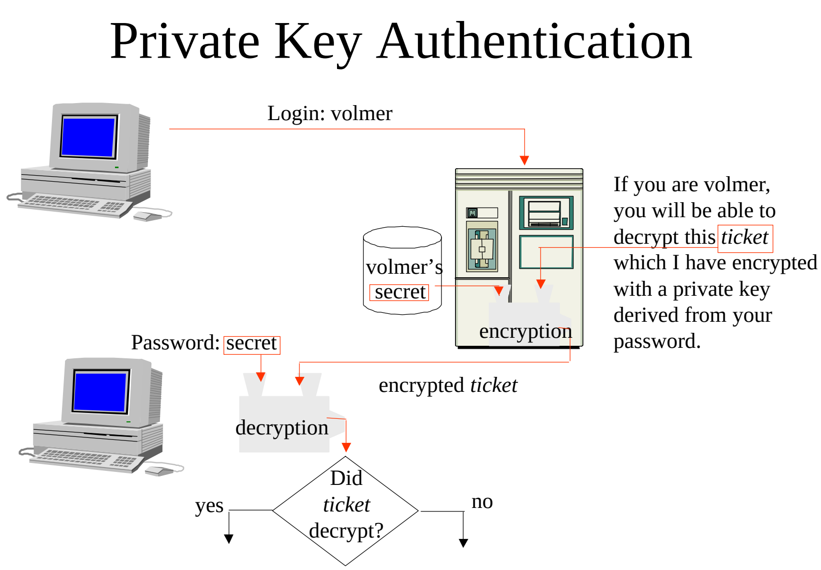
Electronic Forms

For areas using electronic forms, there are commercial turnkey products as well as software that can be adapted to a limited extent. JetFormsT is an electronic forms package that can be used with the Entrust architecture. [Ent] Shana FormsT is an electronic forms package that is used with the Apple Digital Signature environment. An Entrust aware version is also available.

Database Access

For database access, authentication of accessor, and associated privileges may be expressed in database-specific means. The public-key based identity may be different than the database notion of identity, especially if the certificate authority (CA) is not tightly integrated with the database. One commercial example hints at the merging of CA and DBMS. The linkages between databases and certificate issuing and maintenance systems has been identified as a research issue.

Ability for the database client software to authenticate itself to the database as the user is important. The many means of accessing the database: embedded Structured Query Language (SQL), Common Object Request Broker Architecture (CORBA), Distributed Computing Environment (DCE), command-line monitors, and forms builders need to be aware of public-key authentication technology. The Oracle Secure Network Services (SNS) addition to SQL*NET, now part of the Oracle Advanced Networking Option, provides authentication, authorization, and privacy through use of DCE. Barring any direct support for the use of PKI, DCE support for PKI is essential for SQL*NET to take advantage of PKI.



Ad hoc access control allows an application to act differently based on who is making requests of it. Currently, one would have to create application-specific access-control tables, possibly with an associated administrative interface. Web server based access control is an example of ad-hoc access control. Most web servers derived from the NCSA source enforce access control based on the contents of an ".htaccess" file and username/password challenge. Other servers are beginning to use identity certificates to determine access control, or can plug-in this ability. A next logical step is to use digitally signed access-control information to allow decentralized administration of web server access.

Web Browsers

The web browser is arguably where Internet security was first widely introduced. Although the capability to use identity certificates is present in most browsers, the local infrastructure to support issuance of client-side identity certificates is not present in most organizations. In addition, some web browsers, such as Netscape, do not allow a digital signature to be made on demand, such as for signing data submitted by a web-based form or a Java applet. The only use of digital signature currently is for authentication at the beginning of a connection, and perhaps soon for e-mail. This omission will eventually be fixed as the Java applet environment is made more secure, allowing private-key operations to be safely provided to applets.

A remaining problem is that each application stores keying information privately, so that keys acquired by one application, such as a browser, cannot be used with another application, such as a database access program. On Microsoft platforms, since a common cryptographic service is provided to applications, private-key sharing can be achieved in principle. On Unix, no such basic service is provided. Each application developer currently has to implement their own, or use one of possibly many third party key management services.

Web clients (browsers and applets) may authenticate directly using Secure Sockets Layer (SSLv3). An alternate approach is to provide secure web access via a local proxy which talks SSLv3 (e.g., Trade Wave). The limitation with this alternative is that the proxy needs to be running on each possible machine where the user may be running their browser. The server browser and applets cannot perform digital signature because the key management is being handled through the proxy at the client level.

There is some movement in the market towards certificate-based authorization of web access. However, a significant problem is credential or identity passing between the client web browser and back-end applications. When communicating directly with the back-end application, the client can provide strong authentication -- multiple times, if necessary. But through the web paradigm, the interaction is restricted to a single query and reply. While processing a request, the back-end application may have a need to perform some operation, such as connecting to a database, requiring additional user credentials for a short time. At this point, the user needs to be involved in granting the use of additional credentials. The problem of specifying all possibly required credentials and all possible delegates before the computation occurs is difficult, especially as applications become more complex, involving more third-parties. The alternative is granting temporary access to all the user's credentials, or a complex delegation mechanism. Another alternative is forwarding the ability to perform private-key operations to remote clients, most likely with user-verification for each use. This seems to be a ripe area for standardization.

Domain Naming System (DNS)

The basic infrastructure that maps host names to physical addresses can benefit from security, not to prevent host impersonation (which session-level security already addresses), but to prevent denial-of-service attacks against the DNS system, affecting ability to look up host addresses at all. A host key generating and certification process needs to be designed. Client-generated information did not need to be kept in DNS before, but now client-generated public-keys will need to be maintained. Bootstrapping is required to allow for the distribution of host public-key certificates even though the upper-level and peer-level DNS servers are not cross-certified. In the short term, there will need to be locally trusted and cross-certified domains of naming.

Directory Services

A directory service is used to find the public-key associated with a user or entity or determine the certificate revocation status of a given certificate. Such a lookup may be keyed on distinguished name, which, for X.500 naming, means knowing the hierarchical name pointing to a user. Although certificates do not necessarily require X.500 naming (since distributed searching is not typically provided through Lightweight Directory Access Protocol [LDAP]), the user or application still needs to know where to look.

Like DNS, there are security deficiencies in the X.500 and LDAP infrastructure which can be addressed through the use of secure protocols such as SSLv3 to detect tampering with a directory service's reply. Typically a directory service is a combination of locally maintained data, such as e-mail addresses, and personnel data, such as employee ID and telephone numbers. Directory updates are under the control of the one party that maintains the directory. Public-key certificates form a third source of data that needs to be consistent with the other two. Some certificate authority software assumes complete control over the directory. This control does not allow for the directory service model.

Netscape v4 can use LDAP services for looking up e-mail addresses. It does not yet use LDAP for looking up certificates, but it is likely given that Secure Multipurpose Internet Mail Extensions (S/MIME) will soon be supported.

These directory services, other than DNS, are not widely deployed. Ultimately, there may be a combination of infrastructure and ad-hoc, point-to-point key exchange. The Internet Engineering Task Force (IETF) transport level security (TLS) group that is standardizing SSLv3 is including password based authentication for precisely the reason that certificate infrastructure is not currently widely available, and that existing applications already can manage password based authentication. The thought is that deploying security through changes to existing protocols and software is much easier and faster than deploying security through the creation of infrastructure (and software to take advantage of it).

Notary Service

A digital signature by a third party with a time stamp can provide an equivalent of a notary service. Agreement on common signature forms is required at a minimum. A paper-based notary service is a state-licensed, publicly listed service, rather than a locally agreed upon service, and proof of notarization involves a party other than the original parties (e.g. an arbiter). Therefore, the PKI infrastructure used and the digital-signature formats dictated must be interoperable and agreed upon by other parties. There is some public-domain and commercial work being done in this area, but no accepted standards as of yet.

Some potential uses of third-party time stamping are ensuring legality of electronic records, establishment of research records for patent purposes, and non-repudiation for electronic commerce transactions. Digital notary services has been identified as a research issue of interest to DOE.

E-mail

E-mail text can be signed for authentication and optionally encrypted for privacy. The S/MIME standard makes use of digital-signature to provide authentication. Soon there will be many e-mail implementations that make use of digital signature. Each client needs to be able to generate a signature with the user's private-key.

Video Teleconferencing

Video and audio data traveling over the Internet can be encrypted for privacy as well as authentication to provide as much confidentiality as a land-line based call. Multicast security, the protocols and the cryptography used, is still an open research issue. This has been identified as a potential application within DOE. Public key technologies could be used to perform key exchange for privacy of traffic, authentication to limit group membership, and access control to group collaborative documents.

Software Bus

A software bus allows applications to be glued together by providing and defining a common means of invoking operations and passing data between applications. Examples of software buses include tooltalk, CORBA, DCOM, and the "send" facility in the Tcl/Tk language.

Much software on Windows supports the DCOM software bus which allows applications to interact with or control each-other. UNIX applications do not typically come with a software bus, although that may change with the efforts of the Object Management Group in promoting the use of CORBA.

A CORBA interface to Oracle is available, and one is planned for Informix. Certain Netscape server and browser products contain support for IIOP, which promises interoperability between different implementations of CORBA and is in its early stages of adoption. Still, general availability of such functionality is a ways off and subject to vendor idiosyncrasies in implementation.. In addition, authentication and security in software bus services are still in the proposal stage.

DCOM may ultimately become the de-facto standard because of the Microsoft distribution channel. Since DCOM makes use of Generic Security Service Application Program Interface (GSS-API) for security services, DCE can provide a service location and invocation interface. The software bus will authenticate both services and clients to each other. DCE intends to support a public-key like technology with version 1.2, although certificate formats, ability to perform digital-signature, and the use of public-keys to authenticate users and services to each other will not appear for a while.

Remote Login

Remote login is another application area where end-to-end authentication and non-disclosure is needed and where infrastructure has proved a challenge to deploy, or is not present. An example of a remote login application using public-key digital signature with no infrastructure is Secure Shell (SSH).

Operating Systems

For Unix, Entrust/Toolkit allows creation of signature records on files and data buffers. It can acquire x.509v3 certificates (in principle) from any certificate authority, although an Entrust certificate authority is usually used and the certificate registration protocol is not currently publicly documented. Entrust plans to incorporate PKIX-3cmp standards soon. The Toolkit API currently does not allow general use of the private-key, such as to generate an interoperable, detached, signature. Control over the Unix operating system, where security services can be most effectively introduced, is fragmented among many interests, both commercial (HP, Sun, SGI, DEC, SCO, etc.) and non-commercial (FreeBSD, NetBSD, Linux). The providers of third-party operating system substrate are fragmented into at least two major camps: Open Software Foundation with DCE and OMG with CORBA.

For Windows, Microsoft CryptoAPI, part of the Microsoft Internet Security Framework (MISF) supports multiple cryptographic service providers (CSPs), two of which are Rivest Shamir Adelman (RSA) BSAFE library and Entrust/Toolkit (known as Microsoft Exchange). Nine others have expressed intentions of developing CSPs.

The main focus of the third-party CSPs seems to be to support hardware tokens (such as Fortezza cards, other smart cards, split-key signature units, and cryptographic co-processors), and key-escrow, rather than provide alternate implementations of cryptographic algorithms. Basic signature and key-exchange are among the numerous cryptographic services provided. The signature and key-exchange messages are interchangeable between two libraries by the same provider family. However, between two different provider families, no such interoperability is guaranteed. Since the BSAFE signature format is publicly defined, other implementations can potentially interoperate with it. Private-key storage and retrieval is allowed with the BSAFE library, and the formats are documented.

The future of Macintosh in the business environment is looking bleak, but client-side browsers and Java applications should be able to take advantage of digital signature ability on the Macintosh if the browser vendors continue to support the Macintosh and if certificates can be issued to Macintosh based browsers or if private-keys can be transferred to the Macintosh platform.

Hardware

Anywhere data is stored over the long term, such as on magnetic disk, optical disk, or tape, the potential for disclosure is possible and encryption combined with public-key based encryption-key management could be used in place of, or in addition to physical access control. If off-site archival is done, the data may need to be encrypted for assurance, but retrievable at some future time.

Transportable storage, such as tokens, could benefit from encryption of data stored in the unit, but this is no protection from a determined attacker. The role that tokens could play in a public-key based system would be to store trusted certificates, private-keys and encryption keys and perform digital-signature and key-exchange operations. Although standards address physical characteristics of tokens, application specific properties, such as what data is stored and how it is encoded are not yet addressed

For communications hardware, link level encryption could make use of public-key technology for key-exchange.

Chapter 4. Digital Signature Standards

DOE is under increasing pressure to implement digital signatures in applications. Implementation of the digital signature function will require Departmentwide interoperability as well as interface with vendors. To accomplish this, standards guidance is required to assist in reaching the necessary level of interoperability. Uncoordinated efforts can be duplicative, costly, and incompatible. Standards applicable to Digital Signature are to be used by anyone involved in the acquisition, development, implementation, maintenance, or management of applications using digital signature.

Digital signature standards being proposed for adoption or retirement are to be submitted to the Information Technology Standards Program Manager, in the Office of the Chief Information Officer. The Standards Program Manager then initiates the Departmentwide process for adoption or retirement of the proposed standards. For further guidance on standards adoption or retirement, refer to the following documents: *Department of Energy Standards Adoption and Retirement Process* and the *Department of Energy Information Architecture Profile of Adopted Standards*. These document can be found online at the following URL: *http://www-it.hr.doe.gov/standards/*.

The standards identified by the DOE Digital Signature Working Group represent guidance for achieving digital signature interoperability within the DOE community. While these standards are not mandatory, it is recommended that they be incorporated into DOE digital signature implementations. These standards have been through the DOE IT Standards Adoption and Retirement Process and are part of the DOE Profile of Adopted IT Standards and the corresponding Standards Repository. Abstracts of these standards can be found on the DOE Information Architecture Standards Home Page(see above for website address). The standards are divided into five categories: encryption and authentication standards, public key infrastructure standards, standards for enabling technologies concerning the use of digital signature, standards that provide interoperability options, and standards that provide directory services .

Encryption and Authentication

FIPS PUB 46-2 - Data Encryption Standard (DES) is the standard for the encryption of the private key and specifies a FIPS-approved cryptographic algorithm required by **FIPS 140-1.** This FIPS provides a complete description of a mathematical algorithm for encrypting (enciphering) and decrypting (deciphering) binary coded information. DES was first approved in 1977 and was most recently reaffirmed by the Secretary of Commerce in 1993, until December 1998. In 1993 the following statement was included in the standard: "*At the next review (1988), the algorithm specified in this standard will be over twenty years old. NIST will consider alternatives which offer a higher level of security. One of these alternatives may be proposed as a replacement standard at the 1998 review*."

FIPS PUB 140-1 - Security Requirements for Cryptographic Modules is a general standard that, among other things, sets out requirements for cryptographic algorithms. This standard is the only one mentioned by the New Mexico state legislature concerning digital signature.

FIPS PUB 171 - Key Management Using ANSI X9.17 specifies a particular selection of options for the automated distribution of keying material by the federal government when using the protocols of ANSI X9.17-1985. ANSI X9.17-1985 protocols define procedures for the manual and automated management of keying materials and uses DES to provide key management for a variety of operational environments.

FIPS PUB 180-1 - Secure Hash Standard (SHS) is the standard for the hash function. SHS specifies a Secure Hash Algorithm (SHA-1) for computing a condensed representation of a message or a data file.

FIPS PUB 186 - Digital Signature Standard (DSS) specifies a Digital Signature Algorithm (DSA) for the public key portion of a digital signature. DSS was selected by NIST, in cooperation with the National Security Agency, to be the digital authentication standard of the U.S. government. This standard shall be used in designing and implementing public-key based signature systems that federal departments and agencies operate or that are operated for them under contract. Adoption and use of this standard is available to private and commercial organizations. Currently there are few companies that provide products that meet the specifications of FIPS 186, and those that do are for very limited applications.. NIST issued in the Federal Register May 13, 1997 a request for comment for the revision of FIPS 186 in order to utilize commercial off-the-shelf software for digital signatures. The Comment period ended August 11, 1997. According to NIST, the reviewing body is now waiting for the Banking Standards Committee to adopt the ANSI X9 standards regarding the elliptical curve and RSA-based algorithm for financial services. When this occurs, within approximately six months, NIST will then incorporate by reference these standards into FIPS-186, allowing the use of these alternate technologies.

RSA Public Key Cryptography is a public-key crypto system for both encryption and authentication. RSA supplements DES (or any other fast bulk encryption cipher) and is used together with DES in a secure communications environment. For encrypting messages, RSA and DES are usually combined as follows: first the message is encrypted with a random DES key, and then, before being sent over an insecure communications channel, the DES key is encrypted with RSA. Together, the DES-encrypted message and the RSA-encrypted DES key are sent. This protocol is known as an RSA digital envelope.

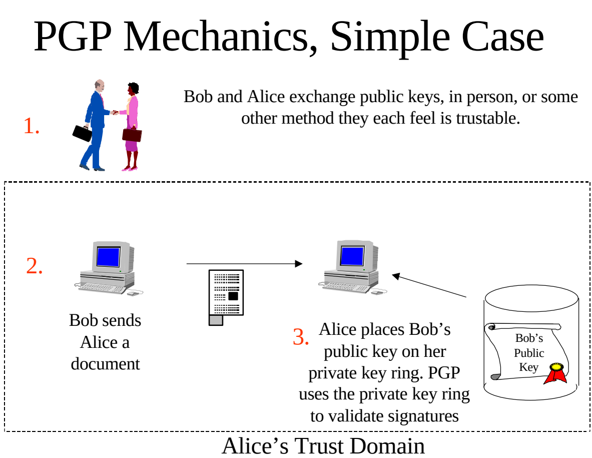
FIPS PUB 196 - Entity Authentication Using Public Key Cryptography specifies two challenge-response protocols by which entities may authenticate their identities to one another. Depending on which protocol is implemented, either one or both entities involved may be authenticated. The defined protocols are derived from an international standard for entity authentication based on public key cryptography. The authentication protocols described in the standards may be implemented in software, firmware, hardware, or any combination thereof.

ISO/IEC 9796:1991 Information Technology -- Security Techniques -- digital signature scheme giving message recovery and **ISO/IEC 9796-2: 1997 Information Technology --Security Techniques -- digital signature schemes giving message recovery -- Part 2: mechanism using a hash function** also deal with encryption and authentication.

Public Key Infrastructure

Minimum Interoperability Specification for PKI Components (MISPC), Version 1, June 5, 1997, supports interoperability for a large scale PKI that issues, revokes and manages digital signature public key certificates, to allow the use of those signatures to replace handwritten signatures in government services, commerce, and legal proceedings, and to allow distant parties, who have no previous relationship, to reliably authenticate each other and conduct business. The MISPC addresses: public key certificate generation, renewal, and revocation; signature generation and verification; and, certificate and certification path validation.

MISPC provides a basis for interoperation between PKI components from different vendors. This specification will be available to companies interested in offering interoperable PKI components, to Federal agencies developing procurement specifications, and to other interested parties. It will be the basis for a NIST reference implementation and an initial root Certification Authority for the Federal PKI.

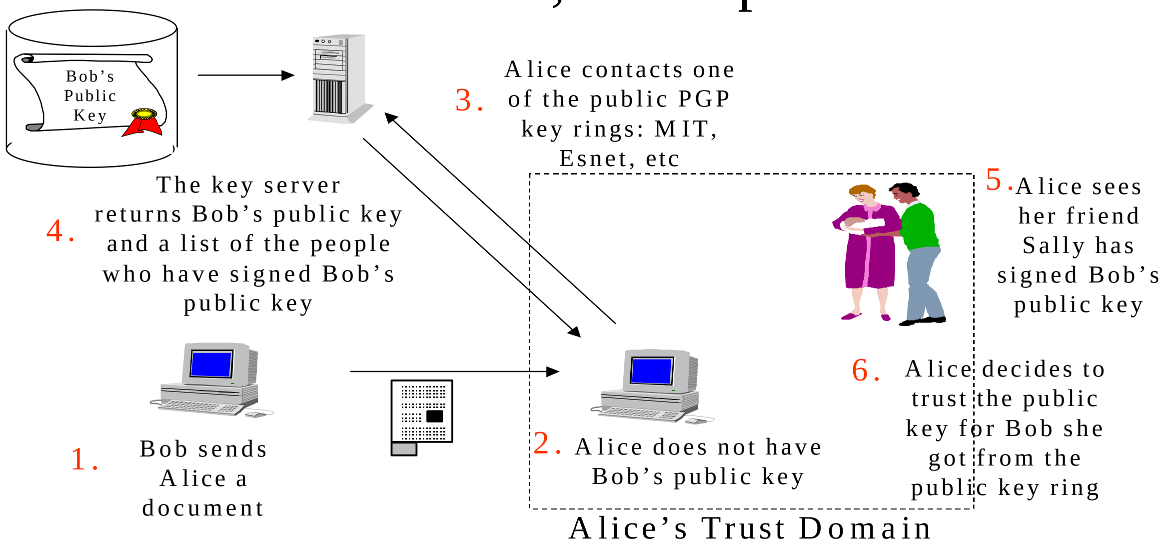


Although there have been several proposed formats for public key certificates, most certificates available today are based on an international standard (ITU-T X.509 version 3). **Revision to ITU-T Recommendation X.509, (Also specified in ANSI X9.55-1995[X9.55] and IEFT Internet Public Key Infrastructure working document [PKIX1]** defines a certificate structure that includes several optional extensions. The X.509 version 3 certificate includes the following: Version, Serial Number, Issuer Signature algorithm, Issuer Distinguished Name, Validity Period, Subject Distinguished Name, Subject Public Key Information, Issuer Unique Identifier (optional), Subject Unique Identifier (optional), Extensions (optional), and Issuer's Signature on all the above fields. The use of X.509v3 certificates is important because it provides interoperability between PKI components.

Applications Technologies

Pretty Good Privacy (PGP) is a high-security cryptographic software application that allows people to exchange messages with both privacy and authentication. Privacy means that only those intended to receive a message can read it. By providing the ability to encrypt messages, PGP provides protection against anyone eavesdropping on the network. Even if a packet is intercepted, it will be unreadable to the snooper. Authentication ensures that a message from a particular person originated from that person only, and that the message has not been altered. The **MIME Object Security Services (MOSS)** protocol, currently in draft form within the Internet Engineering Task

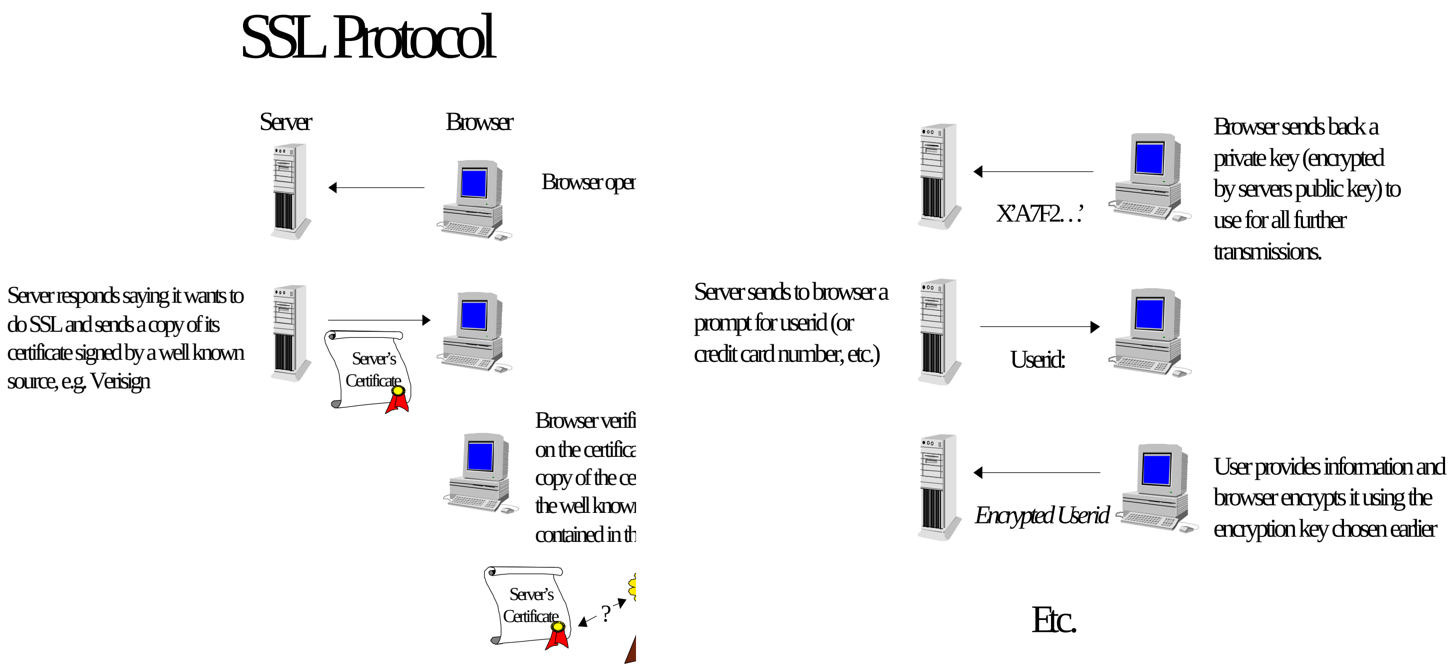
PGP Mechanics, Complex Case



Force (IETF) Network Working Group, uses the multiparty/signed and multiparty/encrypted framework to apply digital signature and encryption services to MIME objects. The services are offered through the use of end-to-end cryptography between an originator and a recipient at the application layer. Asymmetric (public key) cryptography is used in support of the digital signature service and encryption key management. Symmetric (secret key) cryptography is used in support of the encryption service. The procedures are intended to be compatible with a wide range of public key management approaches, including both ad hoc and certificate-based schemes. Mechanisms are provided to support many public key management approaches.

The issue of secure WWW transactions has resulted in two competing proposals: **Secure Sockets Layer (SSL)** and **Secure Hypertext Transfer Protocol (S-HTTP)**. So far neither has been determined to be the winner. Both could be enabling technologies for using WWW technology for sensitive information and secure transactions where data privacy, data integrity, authentication, and nonrepudiation are concerns.

Secure Sockets Layer (SSL) is an open protocol for securing data communications across computer networks. Incorporating RSA data security technology, SSL provides a straightforward method for adding strong security to existing applications and network infrastructures. SSL is application protocol-independent and provides encryption, which creates a secured channel to prevent others from tapping into the network; authentication, which uses certificates and digital signatures to verify the identity of parties in information exchanges and transactions; and message integrity, which ensures that messages cannot be altered en route.



Secure Hypertext Transfer Protocol (S-HTTP) provides secure communication mechanisms between an HTTP client-server pair in order to enable spontaneous commercial transactions for a wide range of applications. The design intent is to provide a flexible protocol that supports multiple orthogonal operation modes, key management mechanisms, trust models, cryptographic algorithms, and encapsulation formats through option negotiation between parties for each transaction.

Kerberos, DCE-SS 1.1 Generic Security Service API (GSS API) is a distributed authentication service that allows a process (a client) running on behalf of a principal (a user) to prove its identity to a verifier (an application server, or just server) without sending data across the network that might allow an attacker or the verifier to subsequently impersonate the principal. Kerberos optionally provides confidentiality and integrity for data sent between the client and server. Version 5 of Kerberos is considered to be the standard.

The Open Software Foundation's Distributed Computing Environment (DCE) Security Service component is based upon Kerberos Version 5. In order to support applications that need to be portable across a variety of underlying security mechanisms, a "Generic Security Service API" (or GSSAPI) [Internet RFC 1508] was designed, which gives access to a common core of security services expected to be provided by several mechanisms. As an accepted standard for distributed authentication and authorization, Kerberos is a fundamental requirement for a robust distributed computing environment.

Interoperability Options

Several IEEE standards provide interoperability options for digital signature technology.

IEEE 1003.1e Portable Operating System Interface (POSIX) – Security Extensions specifies security considerations in terms of data encryption mechanisms, access control, reliability control, systems logging, fault tolerance, and audit facilities. This standard defines security capability necessary to secure kernel operations.

IEEE 1003.2c Portable Operating System Interface (POSIX) – Security Extensions defines the security interface for use by users and batch processing scripts that seek access to secure systems.

IEEE 1003.22 Guide to the POSIX Open Systems Environment – A Security Framework provides a focus for definition and placement of security services around which implementations and API standards activities may coordinate. The standard specifies the types of APIs required to support the security services defined in the framework; identifies existing implementations and their relative maturity as potential base specifications for API standards and those areas with no existing or immature industry practice that require development efforts; provides a tool to help integrators of secure systems understand and structure security services within a distributed system; and provides a framework for structuring security within distributed systems based on ECMA-Security in Open Systems.

IEEE 1003.6 Security Interface Standards for POSIX provides changes and additions for security-related functional requirements and system interfaces in the areas of accountability, extended discretionary access control, mandatory access control, security information labeling, and fine-grained capabilities. The standard provides developers with the option of using interfaces to implement portable applications with security features, and to determine how to apply security policies relating to accountability, discretionary access control, mandatory access control, and capabilities (privilege) to existing interfaces.

Directory Services

X.500 - Information Technology - Open Systems Interconnection - The Directory: Overview of concepts, models, and services is a family of standards and uses a distributed approach to for a global directory service. Local information for an organization is maintained locally in one or more so-called directory system agendas. X.500 offers the following features: Decentralized maintenance; powerful searching capabilities; single global namespace; and structured information framework.

LDAP - Lightweight Directory Access Protocol is a protocol for accessing online directory services. It runs directly over TCP, and can be used to access a standalone LDAP directory service or to access a directory service that is back-ended by X.500. The LDAP Standard defines: A network protocol for accessing information in the directory; an information model defining the form and character of the information; a namespace defining how information is referenced and organized; and an emerging distributed operation model defining how data may be distributed and referenced (v3).

Products that Conform to Proposed Standards

The following products have demonstrated conformance with recommended standards:

Entrust	CygnaCom Solutions

Chapter 5. Records Management

Records managers serving DOE programs and missions face a variety of challenges and opportunities in their attempts to deliver quality records management services in a complex computing technology environment. As the use of digital signature technology becomes more commonplace in DOE business processes, records managers will be presented many new obstacles to overcome in their attempt to serve their customers. These obstacles will arise from changing procedural expectations, new business practices, evolving computing technologies, and the automation of previously manual processes.

Records management functions in the Federal sector are largely performed with paper records. Many of the issues of using digital signature for records management are similar to issues for using electronic versus paper records without digital signature. Including a records management chapter in this document does not mean that extensive use of digital signature for records is contemplated in the near future. However, any current application of digital signature must address records management issues.

When contemplating extensive use of digital signature for records, a DOE enterprise-wide solution should be encouraged, based on requirements commonality and application standardization. A digital signature system needs to be a uniform system for archiving electronic records or documents, address evidentiary issues, and support the belief that electronic documents should be retrievable for many years without concerns regarding unauthorized document modification.

There are several records management issues with regard to digital signature. These are addressed in the following sections.

Storage and Retrieval Problems

Electronic media does not readily store records in a manner supportive of long term document storage. In addition, there are no clear organizational guidelines on who must budget for the eventual data conversion that must occur to keep stored electronic records retrievable over a considerable period of time - Records Management or the originating department?

The systems and file formats in which records are stored will become obsolete, and moving data to newer computers will result in losing the ability to read the original data or validate attached signatures, unless the same digital signature software can be implemented in the new computing environment. How both signature objects and viable software can be preserved across computing architectures and the life cycle of records has not been addressed in most discussions of the implementation of digital signature technology. It is very important to create and maintain an inextricable link between the digital signature and the record throughout its disposition cycle to address concerns about information authenticity.

Paperless Versus Paper Records

It should be clear as to whose responsibility it is to verify that the electronic records adequately document transactions and functions and that the paper copies of these records sent to the record center may be safely destroyed as redundant information. It should be specifically stated that this is the responsibility of Records Management or the owning organization.

One of the primary records concerns at the DOE sites with regards to "paperless" computer systems that use digital signatures is that there is little overlap between procedures for managing paper records and the procedures that apply to information in electronic systems. There is often an expectation that a paper counterpart of an electronic record should be producible on demand, even if the document was not originally printed during its active life. It is also desirable to be able to attest that a paper document was printed at some particular time from a computer system, in a manner similar to what might be an electronic counterpart of a notary.

Consideration of whether electronic documents using digital signatures can be used to replace sending the "record copy" to hard copy records centers is premature at this time. The Savannah River Site has plans to pilot record authentication using digital signature as part of its Documentum electronic document management system. Such records can be retrieved and certified as "not altered" through digital signature validation. However, most sites have not implemented this advanced level of document management, and are still very involved in the integration of electronic and hard copy business processes. Password authentication/E-mail approval is being used and is (slowly) replacing hard copy documents, for many documents that may have formerly been signed.

The issue of managing, in an integrated manner, the digitally signed electronic documents that are stored in a different location from the paper documents that are related to them must be addressed. Scanning has become very cost-effective for the Savannah River Site where a single meta-data database that stores index information for both our paper and electronic holdings is used. At other sites, consideration is being given to using an electronic records system that allows for location cross-referencing of documents. For example, the system could allow one to enter location of the record with a cross-reference to either the paper or electronic record. However, this level of integrated electronic and paper document tracking is beyond the capabilities of most present systems. Lockheed Martin Energy Systems is using the Electronic Information Content Management System (EICMS) to address this issue.

A good solution is to concentrate on properly designating and scheduling the record copy. Since most paper documents are now produced by computer systems, they will increasingly be seen as supportive information that is not really record copy, and therefore no hard copy version should be designated/scheduled as record copy.

Who Signed What?

It is important to be able to determine who signed which version of a document at which point in the business process and which items on a form or document were signed by specific individuals. Due to the manner in which digital signatures are "applied" to electronic documents, it is often difficult to determine what parts of a document were signed by particular individuals. One digital signature or a set of signatures that exist as an "envelope" around a complete document could be confusing in establishing precise responsibilities for the authorization of portions of an electronic record.

Creation of New Records

Due to the perceived importance of electronic documents signed with digital signatures, it is very important that they are associated with records series and, consequently, retention schedules so that they will be retrievable throughout their life cycle.. This will also be required to assure that records are disposed of at proper intervals. It is desirable to have some records management controls designed into the document management aspects of the digital signature computer systems.

It will be very important to assure that the definition of a record is followed closely to prevent creating more electronic records than necessary, as electronic records may not be “cheap to keep.”

One category of new records that will be created through the use of digital signature is certificates. If a digitally signed document is archived, there will be a need to also archive the associated public key certificate. There will be many issues to address concerning how and with what other information this archiving will occur.

National Archives and Records Administration (NARA) Issues

Issues about transmitting electronic records that are digitally signed to the National Archives and Records Administration (NARA) must be addressed. Two of the issues are media and computing infrastructure. NARA will need to accept electronic documents with attached signatures on a long term electronic storage media, such as CD-ROM. NARA will also have to approve the transfer and accept the digital signature. At the present time, NARA is only interested in archiving documents, not digital signature storage and retrieval.

In addition, an interagency PKI might be needed to allow the direct transfer of such files to NARA. Software and interfaces that would enable transferring records to NARA must be acquired or developed. Considerable concern exists about avoiding a separate system just for transmitting records to NARA. A clearly defined records migration strategy must be developed to specify responsibilities for maintaining records, once records are transferred to NARA in a NARA acceptable format. Most sites do not want to maintain duplicate copies of records transferred to NARA.

Recommendations for Records Managers

Records Managers deliver information management services to organizations and individuals. However, they are rarely the initiators of computing technology changes within organizations. The computing systems that Records Managers are in charge of are dedicated to supporting their own operational needs or the needs of their customers. Records management departments usually attempt to follow the technology changes initiated by their customers and to build computing systems that integrate smoothly within the computing architectures used by their customers.

However, Records Managers will need to be constantly reaching out to their various customers, including their own management, to build interest, support, and assistance in meeting these new challenges. The organizations that they support must be ready to include Records Managers in strategic planning meetings and technology implementation projects so that records management issues can be addressed. This need for strong interaction between Records Managers and their customers permeates the issues presented in this chapter.

One significant solution is that records management requirements need to be developed to be added to computer system technical requirements. These requirements would identify the archiving, evidentiary, and validation objectives which must be met by any electronic record/digital signature system. These records management requirements need to be built with significant input from auditors and attorneys who may in the very near future be in the position of challenging an electronic record keeping system. This will also become important as sites begin to implement software such as SAP, that may question the concept of what information is really a database record. Once these criteria are developed; they should be used in conjunction with technical criteria to run pilots at selected DOE sites.

Records Retention Periods

The General Records Schedules (GRS) and Department of Energy Records Schedule (DOERS) provide the retention period of certain records common to most of the DOE complex. It is hoped that the following list will assist in deciding what records might be considered acceptable for the use of digital signatures, in light of current records retention requirements.

- Payroll correspondence (GRS 2.24) - Destroy after 2 years

- Records of reports of routine safety inspections (DOERS 1.1.c) - Destroy after 1 year

- Routine procurement files (less than $25,000 and less than $2,000 for construction projects) (GRS 3.3.a) - Destroy 3 years after final payment

- Routine procurement files including correspondence (over $25,000, and any construction projects greater than $2,000) (GRS 3.3.a) - Destroy 6 years and 3 months after final payment

- Correspondence files relating to facility safety program (DOERS 1.1.b) - Destroy when 10 years old

- Researcher’s biology notebooks (DOERS 1.10.a)
  - Of exceptional value - Permanent (offer to NARA in 25 years)
  - Not of exceptional value - 15 years

- Patent application case files (DOERS 7.2) - Destroy 25 years after date of last action

- Facility design and construction planning (DOERS 14.1.c) - Retain until dismantlement of facility

- Unscheduled records (includes waste characterization) - Permanent (offer to records, research and development files) (NARA in 25 years)

Chapter 6. Legal Considerations

The technology upon which digital signatures is based is neither fully developed nor widely implemented. Since digital signatures are not widely used, the law presently is relatively undeveloped, but will likely develop rapidly once digital signatures are widely deployed. Given the recent emergence of digital signature technology, and the fact that the supporting institutional infrastructure and processes are far from fully in place, the law of digital signatures is relatively undeveloped, with few judicial decisions having been issued.

The Digital Signature Working Group has identified certain risks and potential liabilities as well as responsibilities that should be considered when planning the use of digital signatures. Program officials are encouraged to involve their legal staff early on in any digital signature initiatives. Providing them with a copy of this report will be helpful since it contains useful background and references and could serve to expedite responses to legal questions.

Persons needing to address or resolve legal issues associated with digital signatures should review the American Bar Association Digital Signature Guidelines, published in 1996, which provides a comprehensive framework to assist in the drafting and interpretation of digital signature legislation. This publication has a tutorial to educate readers on how digital signature technology works and a brief overview of signatures and the law in general. The text of the guideline provides general statements of principle, which is intended as a common framework of unifying principles, and comments on these general principles, for the use in drafting digital signature statutes. Such a review will provide a good general perspective regarding the use of digital signatures and valuable insight concerning the identification and allocation of specific risks among all parties involved.

The American Bar Association Digital Signatures Guidelines Tutorial says that in order to achieve the basic purposes of signatures, a signature must have the following attributes:

- **Signer authentication**: A signature should indicate who signed a document, message or record, and should be difficult for another person to produce without authorization.

- **Document authentication**: A signature should identify what is signed, making it impracticable to falsify or alter either the signed matter or the signature without detection.

- **Affirmative act**: The affixing of the signature should be an affirmative act which serves the ceremonial and approval functions of a signature and establishes the sense of having legally consummated a transaction.

- **Efficiency**: Optimally, a signature and its creation and verification processes should provide the greatest possible assurance of both signer authenticity and document authenticity, with the least possible expenditure of resources.

Digital signature technology generally surpasses paper technology in all these attributes. The likelihood of malfunction or tampering in a digital signature cryptosystem designed and implemented according to federal/industry standards is extremely remote and is far less than the risk of undetected forgery or alteration on paper or of using less secure electronic signature techniques.

Legal issues involving digital signatures can be divided into three categories:

- Evidentiary issues
- Liability/responsibility issues
- Enforceability/Non-repudiation issues

A discussion of evidentiary issues follows. Other issues are not discussed in this issuance of the document due to a lack of definitive answers.

Evidentiary Issues

Currently, the use of digital signature technology is most widespread in the area of commerce. The courts have not yet dealt with records maintained in digitized form and may not even comment for several years, if history is any guide. It took several hundred years for the courts to accept paper records into evidence, approximately 40 years to accept microfilm, and approximately 10 years to accept computer-generated records. Similarly, the acceptance of this new technology will depend upon the comfort level of the judges and administrators.

A study conducted by Martin Marietta Energy Systems to develop a Prototype Electronic Records Management System (PERMS) for the U.S. Army Information System Command, under contract to the DOE in Oak Ridge, Tennessee, was initiated to test the concept of combining an electronic document management system and a digital signature system into an overall system that could withstand judicial scrutiny. The electronic signature capability was designed to meet four requirements: not forgeable, authenticatable, unalterable and non-reusable.

Several recommendations were made during the PERMS research project to assure compliance with legal statutes. Providing unrestricted access to appropriate users, good system security, adequate data interchange formats, and means for the appropriate disposition of documents answered many of the concerns of the National Archives and Records Administration (NARA). Steps to assure the legal admissibility of documents as court evidence include documenting business processes, documentation of system security, identification of records media life cycle, and coordination of issues with records management staff and legal counsel.

It was recommended that a written agreement between authorized system users and system managers be executed which specifies jurisdiction under whose laws the agreement is to be governed and the forum of litigation of disputes, as well as a stipulation that the parties will be bound by their digital signatures. Although such efforts will not preclude all disputes, they will serve to support acceptance of the overall validity of digital signatures pending legal and/or regulatory interpretation.

Current legal attitudes toward computer records in general are reflected in both statutes and case law. The Uniform Rules of Evidence provide the basis for admitting all types of records, including computer records, into evidence. The rules specifically refer to computer records in Rule 803(6) by using the term "data compilation." Under Federal Rule of Evidence 803(8), however, if the only record is electronic, procedures should be established and followed so that: (1) the date of the record can be determined; (2) the date of any alterations will be automatically recorded by the system; and (3) it will be evident that the document was authorized to be issued ("signed").

The Federal Rules of Evidence Rule 1001(1) states "writings" and "recordings" consist of letters, words, or numbers, or their equivalent, set down by handwriting, typewriting, printing, photostating, photographing, magnetic impulse, mechanical or electronic recording, or other form of data compilation." Nothing in this definition precludes the use of encryption technology. Similarly, when defining an original, Rule 1001(3) states "an "original" of a writing or recording is the writing or recording itself or any counterpart intended to have the same effect by a person executing or issuing it.... If data are stored in a computer or similar device, any printout or other output readable by sight, shown to reflect the data accurately, is an "original".

State Legislation for Electronic and Digital Signatures

Currently there are 40 states that have either considered or enacted electronic authentication laws. Of these, 23 states have enacted some type of limited law statute, and 10 states have enacted a general statute. The majority of the states have enacted electronic signature laws, but only a few have enacted digital signature laws. While the terms electronic signature and digital signature are often used interchangeably, the definitions are different. To simplify, digital signatures utilizes an encryption methodology, while an electronic signature uses letters, characters or symbols.

Most of the states digital and electronic signature initiatives fall into three categories:

- Prescriptive - Statutes delineate specific PKI schemes for digital signatures and have a general applicability. Utah is an example of this model.

- Criteria-based - Statutes recognize the authentication of digital or electronic signatures, provided the signatures satisfy certain criteria of reliability and security. California is the leading model of criteria-based approach.

- Signature enabling - Statutes recognize electronic signatures and documents in a manner that is parallel to traditional signature and writing laws. These are technology-neutral as they adopt no specific technological approach or criteria. Massachusetts is the leading state for this model.

For a more in-depth analysis of the types of models and the statutes enacted by each state, see the site for Internet Law and Policy Forum at http://www.ilpf.org/digsig/digsig.htm. The following states have enacted digital signature technology statutes: Florida, Indiana, Minnesota, Mississippi, New Hampshire, New Mexico, Oregon, Utah, and Washington.

Federal Agencies

The Food and Drug Administration (FDA) issued regulations (21 CFR part 11) that provide criteria for acceptance by the FDA, under certain circumstances, of electronic records, electronic signatures, and handwritten signatures executed to electronic records as equivalent to paper records and handwritten signatures executed on paper. The effective date of these regulations was August 20, 1997. The rule sets forth controls for document encryption and the use of appropriate digital signature standards to ensure record authenticity, integrity, and confidentiality.

Federal Legislation

Currently, there are no Federal statutes about digital signature. However, it is anticipated that there will be Federal legislation on the topic. Several bills that have been proposed are discussed in the following paragraphs. Information on the status of these bills is published on the World Wide Web at *http://www.congress.gov/*

Senate Bill 909: Secure Public Networks Act, introduced in June, 1997 by Senator McCain (commonly referred to as the McCain/Kerry bill) mandates the use of key recovery encryption in any federally supported network, including universities. The bill also states that law enforcement would require only a subpoena to access private keys, whereas current federal regulations require a court order. This bill was passed by the Senate Commerce Committee in June, 1997.

H.R. Bill 695: Security and Freedom Through Encryption (SAFE), introduced in February, 1997 by Representative Goodlatte originally allowed for the exportation of encryption technology and sought to ban federally mandated key recovery. Recent amendments made by legislators have instead "marked up" the bill, or amended it at the committee level, to reflect the wishes of the Federal Bureau of Investigation (see below) and other law enforcement agencies that want "wiretap" access to all encrypted e-mail and other digital files. The amendment, passed 45 to 1 on September 9, 1997, by the House National Security Committee, radically changed the SAFE bill by reaffirming government export regulations on cryptography. The amendment would return control of all encryption exports to the president, who would set a "maximum level" for exportable encryption once a year. After a one-time review, all products that didn't exceed that limit would be allowed to be exported.

The Federal Bureau of Investigation in September, 1997, began circulating a new FBI draft encryption legislation that would impose mandatory key recovery This legislation would impose full domestic controls on the manufacture and use encryption. In addition, it would require all network service providers that offer encryption products or services to their customers to ensure that all messages using such encryption can be immediately decrypted without the knowledge of the customer. This would apply to telephone companies and to online service providers such as America Online and Prodigy.

H.R. 2937, Electronic Financial Services Efficiency Act of 1997, provides that in any written communication with any Federal agency or instrumentality, or any U.S. court, which calls for a signature, any party to the communication may affix a digital signature with a certificate issued by a trusted third party. Also, all forms of electronic communication that comport with the standards prescribed by this Act shall have standing equal to paper-based written signatures with respect to Federal agencies, courts, and instrumentalities, as well as in general.

The bill also establishes the National Association of Certification Authorities, of which any person wishing to provide electronic authentication services shall be a registered member. It prescribes membership guidelines and requires the Association to establish the Electronic Authentication Standards Review Committee, with rulemaking and enforcement powers, which shall: establish, develop, and refine criteria for application to the emerging electronic authentication industry; and report biannually to the Secretary of the Treasury. This legislation is in committee.

H.R. 2991, Electronic Commerce Enhancement Act of 1997, is in committee. It directs the Assistant Secretary for Communications and Information (the head of the National Telecommunications and

Information Administration) of the Department of Commerce to conduct an ongoing study of and report to specified committees concerning the enhancement of electronic commerce due to the use of digital signatures pursuant to this Act. It directs the Director of the Office of Management and Budget to establish a method for each Federal agency to make its forms available electronically. It provides for making payments electronically pursuant to such forms. It sets forth provisions concerning guidelines and standards for digital signatures and certificates. It permits employers to store forms electronically if such forms are submitted electronically.

Choice of Law

Concerns have been expressed over which law, state or federal, would control an electronic record. Many contracts state the choice of law to be used in contract disputes, either federal or state.

Chapter 7. Next Steps

The Digital Signature Working Group (DISIWG), founded in July 1996, is made up of DOE staff, both Federal and contractor, who are investigating and implementing the technology at their sites. They meet once a month via teleconferencing to discuss issues of mutual concern. DISIWG members served in subgroups to write portions of this document. Participation in DISIWG is open to all DOE elements, both Federal and contractor. DISIWG will continue to function as a focal point for collaboration and cooperation and sharing of knowledge and experience in the area of digital signature.

This first issuance of digital signature guidance and considerations serves as an introduction to the topic. Periodic updates are expected, as DISIWG members have more experiences to share, as the technology matures and is more widely used, and as legislation is enacted.

One of the current pilot applications of digital signature is the Chief Financial Officer (CFO) application with Travel Manager. The CFO is building on a framework established by the National Institute of Standards and Technology (NIST) and is using a solution proposed by CygnaCom Solutions. The Assistant Secretary for Energy Efficiency and Renewable Energy (EE) is using the same solution for a procurement application.

Sandia National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Kansas City (Allied Signal), and the Assistant Secretary for Information Management in Germantown are all cross-certified. All locations are using Entrust software, and are experiencing no significant problems. The total user community numbers around 1000. Savannah River, Oak Ridge, and Pacific Northwest National Laboratory are in the process of joining this community. The Headquarters location is acting as the certificate authority for all DOE Federal staff.

Chapter 9 of the Telecommunications Security Manual, DOE M 200.1-1, defines the roles, requirements, and responsibilities for establishing and maintaining and the documentation necessary to ensure that all certificates are managed in a manner that maintains the overall trust required to support a viable PKI. This chapter is being reviewed and enhanced through the DOE Directives process. When the process is complete, Chapter 9 should serve as a broadly based policy for PKI at DOE.

A possible direction for DISIWG is the shepherding of a lightweight PKI infrastructure that deals with broad issues, such as what fields should be included in an X.500 directory or how to locate, establish, and authenticate the identity of a certificate authority.